PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : B01D 24/08 — A1

(11) International Publication Number: WO 93/18837

(43) International Publication Date: 30 September 1993 (30.09.93)

(21) International Application Number: PCT/US93/02631

(22) International Filing Date: 22 March 1993 (22.03.93)

(30) Priority data: 07/854,222 (ABN) 20 March 1992 (20.03.92) US

(71)(72) Applicant and Inventor: SPANGRUD, Bruce, D. [US/US]; 7560 S.W. Escalon Place, Beaverton, OR 97005 (US).

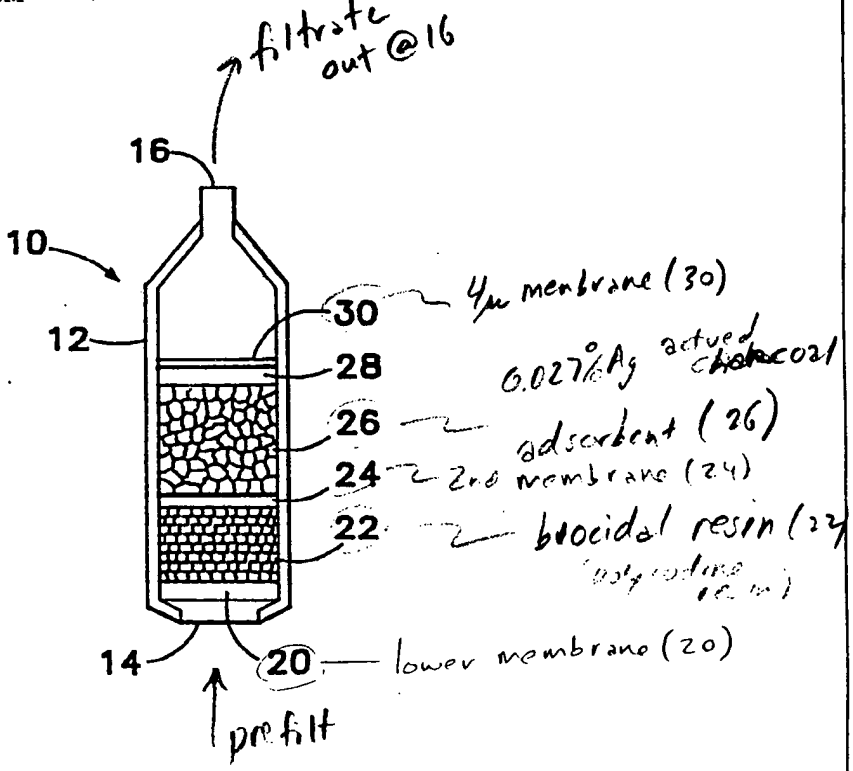
(74) Agent: BROWN, Glenn, C.; Marger, Johnson, McCollom & Stolowitz, 621 S.W. Morrison, Suite 650, Portland, OR 97205 (US).

(81) Designated States: AU, BR, KR, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.

→ straw, canteen OR squeeze bottle embodiments

(54) Title: WATER PURIFICATION SYSTEM



(57) Abstract

A portable water purification system (10) is provided for removing solid, chemical, and biological contaminants from water. The system (10) includes five purification stages, including three filtering stages (20, 24, 28), an adsorbent stage (26), and a biocidal resin (22), all disposed within a housing (12). The system may further include the five purification stages disposed within a drinking straw, or within a water container such as a squeeze bottle or a canteen.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	FR	France	MR	Mauritania
AU	Australia	GA	Gabon	MW	Malawi
BB	Barbados	GB	United Kingdom	NL	Netherlands
BE	Belgium	GN	Guinea	NO	Norway
BF	Burkina Faso	GR	Greece	NZ	New Zealand
BG	Bulgaria	HU	Hungary	PL	Poland
BJ	Benin	IE	Ireland	PT	Portugal
BR	Brazil	IT	Italy	RO	Romania
CA	Canada	JP	Japan	RU	Russian Federation
CF	Central African Republic	KP	Democratic People's Republic of Korea	SD	Sudan
CG	Congo			SE	Sweden
CH	Switzerland	KR	Republic of Korea	SK	Slovak Republic
CI	Côte d'Ivoire	KZ	Kazakhstan	SN	Senegal
CM	Cameroon	LI	Liechtenstein	SU	Soviet Union
CS	Czechoslovakia	LK	Sri Lanka	TD	Chad
CZ	Czech Republic	LU	Luxembourg	TG	Togo
DE	Germany	MC	Monaco	UA	Ukraine
DK	Denmark	MG	Madagascar	US	United States of America
ES	Spain	ML	Mali	VN	Viet Nam
FI	Finland	MN	Mongolia		

WATER PURIFICATION SYSTEM

Background of the Invention

The present invention relates to drinking water purification systems, and particularly to portable drinking water purifiers for use in purifying water as it is drunk from a container, from a water distribution system, or directly from a local body of water.

In locations where a clean and safe water supply is not available, precautions must be taken to avoid being poisoned or infected by contaminants in the drinking water. This problem can arise in a remote area, during an emergency which disrupts normal water supplies, or in areas of the world where a reliably pure water supply is not available. This problem is particularly acute in areas where highly infectious diseases, such as cholera for example, are found in local water supplies. In those cases, drinking water must first be treated by boiling, or by chemical treatment. In addition, in these instances access to water may be limited, making it necessary to carry a temporary supply of drinking water in some type of container.

None of the known methods or treatments for water purification addresses all of these problems satisfactorily. Filtration will remove solids, and in some of the relatively large biological organisms, but will not remove all biological organisms or chemical contaminants. Filtering using known filtration devices is time consuming, and the filters are bulky to carry making them impractical for daily use. Boiling the water may kill the biological organisms in the water, but will not remove all the solid and chemical contaminants. Boiling requires a fire and cookware, and is also time consuming. In addition, the required boiling time for effective purification may vary for different organisms and at altitudes, making it difficult if not impossible to know when sufficient treatment has occurred. Chemical treatment is also time consuming, the required treatment time also may vary for various organisms, and often imparts an objectionable taste to the water.

A need remains for an improved portable water purification system for use in purifying contaminated drinking water supplies, which is readily used for drinking from a container,from an open body of water, or from a water supply system. The need also exists for an improved purification system which provides purified drinking water which is completely free of all harmful biological organisms, and which does so uniformly regardless of the particular organisms in the water.

Summary of the Invention

It is an object of the invention to provide an improved water purification system for use when drinking water from a container, an open body of water, or a water distribution system, and which removes solid, chemical, and all harmful biological contaminants from the water.

It is another object of the invention to provide a water purifier for use with a container which is insertable into the container.

The present invention is an improved portable water purifier for use in drinking water contained from a container, an open body of water, or a water distribution system. A water purifier according to the present invention comprises a body having an inlet and an outlet, and a five stage-purifying means disposed within the body. The body is preferably formed from polyethylene or other polymeric material which has been molded into a generally cylindrical, hollow shape, and which is insertable into a container. The body preferably has an inlet opening and an outlet opening at its respective ends, and a portion which is insertable into the spout or other opening of the container. The body may include means for sealingly engaging the spout of the container to prevent bypassing of the purifier. The sealing means preferable comprises a sealing outer surface on the body having a diameter such that when a portion of the body is inserted into the spout of the canteen, the sealing outer surface engages the spout with an interference fit. The sealing means also comprises a lip extending outwardly from the body for engaging an outer end

surface of the canteen spout, which also properly positions the purifier body in the canteen. When fitted to the canteen, the body will preferably allow the normal cap to be fitted to the canteen or container. In the case of canteens for military or emergency use which are adapted for drinking while wearing a gas mask, the purifier will preferably allow the normal cap and gas mask connections to remain operative. Alternatively, the body may be an integral part of a delivery tube which delivers water from inside the container to the drinker.

The five-stage purifying means within the body preferably includes means for removing solids, for removing chemical contaminants, and for completely destroying or removing all harmful biological organisms in the water, although it may comprise more than five stages. The purifying means preferably comprises first and second porous membranes with finely divided, silver-impregnated activated charcoal disposed therebetween, and further comprises a third porous membrane with a biocidal resin disposed between the second and third membranes. Porous solids may be used in place of porous membranes. The purifying means further includes means for providing a minimum residence time of water in the purifier to completely destroy all harmful biological organisms in the water.

Brief Description of the Drawings

FIG. 1 is a cross-sectional side view of a five-stage portable water purification system according to the present invention.

FIG. 2 is a cross-sectional side view of a three-stage portable water purifier according to the present invention.

FIG. 3 is a cross-sectional side view of a five-stage portable water purifier according to the present invention installed in a military-style canteen.

FIG. 4 is a partial cutaway perspective view of a further embodiment of a five-stage portable water purification system according to the present invention.

FIG. 5 is a partial cutaway perspective view of a further embodiment of a

five-stage portable water purification system according to the present invention.

Detailed Description of the Preferred Embodiments

Referring to FIG. 1, the preferred embodiment of a water purifier according to the present invention is shown generally at 10. Purifier 10 includes hollow body 12 which is molded in one step from food-grade polyethylene, although other materials may be used as well. The use of polyethylene for body 12 is advantageous in that polyethylene remains flexible throughout a broad range of temperatures, allowing body 12 to conform to slight variations or deformations in the spout of the canteen or container.

Body 12 includes inlet 14 and outlet 16. Lip 18 is formed around inlet 14 to prevent large debris from completely blocking inlet 14, and for supporting and retaining lower membrane 20 within body 10. Lower membrane 20, manufactured by Porex, is a self-supporting, variable density porous membrane which rejects particles greater than about 5.5 microns in size. Membrane 20, as well as membranes 24 and 28 reference below, are formed by sintering 100-micron-diameter particles of polypropylene into disc shaped membranes. Lower membrane 20 is sized and shaped to fit snugly within body 12 to prevent bypassing of water past lower membrane 20.

Supported upon lower membrane 20 is a 3-4 cc quantity of granular biocidal resin 22, preferably Penta-Pure™ resin, a finely divided, iodine impregnated resin for killing organisms such as bacteria, viruses, protozoa and the like which may be in the water. Disposed above biocidal resin 22 is middle membrane 24. Middle membrane 24, is a variable density porous polypropylene foam, manufactured by International Rubber Inc.. As with lower membrane 20, middle membrane 24 is sized and shaped to fit snugly within body 12 to prevent any bypassing of water.

Supported on middle membrane 24 is granular activated charcoal 26, preferably impregnated with 0.027% w/w silver according to EPA industry

standards. Activated charcoal 26 removes chemical contaminants, some biological organisms, offensive tastes, odors and discoloration from the water. Located above activated charcoal 26 is upper membrane 28. Upper membrane 28 is also a variable density porous polypropylene membrane as described above, which rejects any particles greater than about 4.0 microns in size. As with membranes 20 and 24, upper membrane 28 is sized and shaped to fit snugly within body 12 to prevent any bypassing of water. Retainer 30 is fitted over upper membrane 28 to hold it in place in body 12. Retainer 30 is preferably a flat circular ring of stainless steel having radiating arms which engage the inner surface of body 12 to hold retainer 30 and the other purifying elements in place. Those skilled in the art will recognize that other types of retainers may be used as well.

Under the suction of 2-4 inches of mercury, the maximum pressure drop which a typical person can generate, water will pass through membranes 20, 24, and 28 at or below a fixed rate. The rate assures sufficient contact time of the water with the 3-4 cc of biocidal resin to assure complete biological decontamination of the water containing up to the following concentrations of typical biological organisms: E. Coli - 1.0×10^6 per ml; cholera - 1.5×10^6 per ml; polio - 6.0×10^4 per ml; giardia cysts - 2.0×10^4 per ml.

The pressure drop across the membranes also ensures that the membranes act as check valves in that water pulled into the housing by the user under suction will not flow back out of the housing merely under the force of gravity.

A purifier according to the present invention may also include any number of additional stages or purifying elements in conjunction with those as depicted in FIG. 1.

Turning to FIGS. 2 and 3, a water purification system 10 according to the present invention for use with a canteen is shown. Purification system 10 is installed by inserting its inlet end 36 into the spout 34 of a canteen 32. The purifier is properly positioned in spout 34 when lip 18 is in contact with end surface 36 of spout 30. Outer sealing surface 38 on body 12 is sized to engage the inner surface

40 of spout 30 with an interference fit. In the preferred embodiment, lip 18 and sealing surface 38 together provide a watertight and airtight seal to prevent leakage of water and air through spout 30 past purifier 10. To drink from canteen 32, cap 42 is removed, and a person drinks by turning canteen 32 up, and drawing water through spout 30. A light suction is required to draw water through the purification stages. When finished drinking, the cap 42 is replaced. Since body 12 fits within spout 30 and canteen 32, and since lip 18 does not extend outwardly past end surface 36, canteen cap 42 may be fitted without removing purifier 10. Canteen 32 can then be conveniently stored in its normal manner, and may be used without inserting and removing purifier 10 for each use. The purifier 10 may be readily removed and reinstalled for refilling the canteen. The purification system according to the present invention may also include a tubular extension extending downwardly from the inlet end to allow drinking from the canteen without upturning it.

A five stage purifier according to the preferred embodiment will purify approximately 40 quarts of water before losing its effectiveness. Those skilled in the art will recognize that alternative filtering, adsorption or biocidal stages may be substituted which increase or decrease the longevity of the purifier.

Certain military canteens are fitted with a cap 42 which is designed to allow a person to drink from the canteen while wearing a gas mask. Cap 42 includes an opening 43 and a valve 44 formed in its top surface 45 which is normally held in sealing engagement against opening 43. A user wearing a gas mask connects a drinking tube nipple (not shown) into opening 43 which pushes valve 44 away from opening 43, allowing water to be drawn through opening 43 and through the tube to the user.

According to this preferred embodiment, when cap 42 is in place on spout 30, valve assembly includes an open area 60 within body 12 for receiving the downwardly extending portion of valve assembly 48 within body 12 and above upper membrane 28. Upper area 60 has a sufficient inner diameter and height to allow valve assembly 48 to open and close normally, and to allow purifier 10 to

function normally, when a person using a gas mask is drinking from canteen 32 as described above.

In FIG. 4 is shown an embodiment of the five stage purification system including a housing 12 which is shaped generally like a drinking straw. Attached to the outlet is a mouthpiece 50. The housing is preferably of polystyrene, ABS, or PVC. The housing is preferably about 6 inches long, with an inner diameter of approximately on half inch. The mouthpiece 50 has an opening 52 sized to limit the flow of water through the housing to the maximum flow compatible with complete biological decontamination as described above.

Turning to FIG. 5, a further embodiment of the invention is shown as a drinking bottle 60 of molded plastic, which preferably has a capacity of one liter. Bottle 60 has a mouth 62 and a threaded cap 64 for sealing the mouth 62. Hole 66 is formed in cap 64, and tube 68 passes therethrough. Tube 68 is sized to slide through hole 66 with a very slight interference fit sufficient to restrict the flow of air around tube 68 into or out of the bottle. The purification system housing 12 is connected at its outlet 16 to the lower end of tube 68. A user drinks from the bottle by applying a suction to the upper end of tube 68 and drawing water through tube 68 . Alternatively, bottle 60 may be gently squeezed to create a slight pressure within bottle 60, and drive water upward through the housing 12 and the purification stages, and through tube 68 to the user.

Those skilled in the art will recognize that modifications may be made in detail of the above embodiments without departing from the scope of the invention. We claim all such modifications.

Claims

1. A portable water purification system comprising:

an elongate housing having a lower end and an upper end, said lower end including surfaces defining a water inlet for admitting water into the housing, and said upper end including surfaces defining a water outlet;

solids purification means disposed within the housing for removing solid contaminants from the water;

chemical purification means disposed within the housing for removing chemical contaminants from the water; and

biological purification means disposed within the housing for killing biological organisms in the water.

2. A portable water purification system according to claim 1 wherein said solid, chemical, and biological purification means comprise five sequential purification stages.

3. A portable water purification system according to claim 1 wherein said five sequential purification stages comprise:

said solid purification means including a lower water permeable member located in said housing above said water inlet;

said biological purification means including a biocidal resin above said lower water permeable member;

a middle water permeable member above said biocidal resin, said lower and middle water permeable members cooperatively retaining said biocidal resin within said housing;

said chemical purification means comprising activated charcoal located above said middle water permeable member; and

an upper water permeable member above said activated charcoal, said middle

and upper water permeable members cooperatively retaining said activated charcoal within said housing.

4. A portable water purification system according to claim 3 wherein at least one of said water permeable members is sufficiently permeable to a predetermined limited flow of water under a pressure differential up to approximately 4 inches of mercury.

5. A portable water purification system according to claim 4 wherein said biocidal resin comprises a sufficient quantity of biocidal resin to kill cholera causing bacteria in said flow of water.

6. A portable water purification system according to claim 4 wherein said biocidal resin comprises a sufficient quantity of biocidal resin to kill giardiasis causing cysts per milliliter in said flow of water.

7. A portable water purification system according to claim 3 wherein said biocidal resin comprises an effective amount of iodine.

8. A water purification system according to claim 2 wherein the activated charcoal further includes an adsorbent enhancer.

9. A portable water purification system comprising:

a canteen;

an elongate housing having a lower end and an upper end, said lower end including surfaces defining a water inlet for admitting water into the housing, and said upper end including surfaces defining a water outlet;

solids purification means disposed within the housing for removing solid contaminants from the water;

chemical purification means disposed within the housing for removing chemical contaminants from the water; and

biological purification means disposed within the housing for killing biological organisms in the water;

the housing including means for operatively engaging an opening in the canteen for directing the water from the canteen into the inlet opening; and

a portion of the housing being disposed within a portion of the canteen.

10. A portable water purification system according to claim 9 wherein said solid, chemical, and biological purification means comprise five sequential purification stages.

11. A portable water purification system according to claim 10 wherein said five sequential purification stages comprises:

said solid purification means including a lower water permeable member located in said housing above said water inlet;

said biological purification means including a biocidal resin above said lower water permeable member;

a middle water permeable member above said biocidal resin, said lower and middle water permeable members cooperatively retaining said biocidal resin within said housing;

said chemical purification means comprising activated charcoal located above said middle water permeable member; and

an upper water permeable member above said activated charcoal, said middle and upper water permeable members cooperatively retaining said activated charcoal within said housing.

12. A portable water purification system according to claim 11 wherein at least one of said water permeable members is sufficiently permeable to a predetermined

limited flow of water under a pressure differential up to approximately 4 inches of mercury.

13. A portable water purification system according to claim 12 wherein said biocidal resin comprises a sufficient quantity of biocidal resin to kill cholera causing bacteria in said flow of water.

14. A portable water purification system according to claim 12 wherein said biocidal resin comprises a sufficient quantity of biocidal resin to kill giardiasis causing cysts in said flow of water.

15. A portable water purification system according to claim 11 wherein said biocidal resin comprises an effective amount of iodine.

16. A water purification system according to claim 11 wherein the purifying means includes an adsorbent enhancer.

17. A water purification system according to claim 9 wherein the housing includes a surface for engaging an inner surface of the canteen spout in an interference fit with when a portion of the filter body is inserted into the canteen spout.

18. A water purification system according to claim 9 wherein the housing includes a lip extending outwardly from the filter body for sealingly engaging a surface of the canteen spout.

19. A filter according to claim 9 wherein the housing includes surfaces defining threads for engaging a complementary thread of a canteen spout.

20. A filter according to claim 9 wherein the means for operatively engaging the housing to the canteen includes means for operatively engaging the housing to a canteen which is adapted for dispensing water to a person who is wearing a gas mask.

21. A water purification system according to claim 1 which further includes a tapered mouthpiece surrounding the housing upper end and water outlet, said mouthpiece for being received in a user's mouth.

22. A water purification system according to claim 21 wherein said mouthpiece includes surfaces defining an opening sized to restrict the flow of water to the user to assure complete biological purification of the water.

23. A portable water purification system comprising:

a container for storing water;

said container including means defining an opening communicating with the interior of the container;

a drinking tube having a mouthpiece and a lower end, said drinking tube extending through said opening and said lower end being disposed within said container;

an elongate housing having a lower end and an upper end, said lower end including surfaces defining a water inlet for admitting water into the housing, and said upper end including surfaces defining a water outlet;

solids purification means disposed within the housing for removing solid contaminants from the water;

chemical purification means disposed within the housing for removing chemical contaminants from the water; and

biological purification means disposed within the housing for killing biological organisms in the water;

said housing being located within said container; and

said housing outlet being operatively connected to said drinking tube lower end.

24. A portable water purification system according to claim 23 wherein said solid, chemical, and biological purification means comprise a five sequential purification stages.

25. A portable water purification system according to claim 23 wherein said five sequential purification stages comprise:

said solid purification means including a lower water permeable member located in said housing above said water inlet;

said biological purification means including a biocidal resin above said lower water permeable member;

a middle water permeable member above said biocidal resin, said lower and middle water permeable members cooperatively retaining said biocidal resin within said housing;

said chemical purification means comprising activated charcoal located above said middle water permeable member; and

an upper water permeable member above said activated charcoal, said middle and upper water permeable members cooperatively retaining said activated charcoal within said housing.

26. A portable water purification system according to claim 25 wherein at least one of said water permeable members is sufficiently permeable to a predetermined limited flow of water under a pressure differential up to approximately 4 inches of mercury.

27. A portable water purification system according to claim 26 wherein said

biocidal resin comprises a sufficient quantity of biocidal resin to kill cholera causing bacteria in said flow of water.

28. A portable water purification system according to claim 26 wherein said biocidal resin comprises a sufficient quantity of biocidal resin to kill giardiasis causing cysts in said flow of water.

29. A portable water purification system according to claim 25 wherein said biocidal resin comprises an effective amount of iodine.

30. A water purification system according to claim 24 wherein the activated charcoal further includes an adsorbent enhancer.

31. A water purification system according to claim 4 wherein at least on said water permeable member is sufficiently resistant to a flow of water to retain water within said housing against the force of gravity.

32. A portable water purification system according to claim 5 wherein said biocidal resin comprises a sufficient quantity of biocidal resin to kill up to 1.5×10^6 cholera causing bacteria per milliliter in said flow of water.

33. A portable water purification system according to claim 6 wherein said biocidal resin comprises a sufficient quantity of biocidal resin to kill up to 2.0×10^4 giardiasis causing cysts per milliliter in said flow of water.

34. A water purification system according to claim 8 wherein said adsorbent enhancer comprises silver.

35. A portable water purification system according to claim 12 wherein at least one of said water permeable members is sufficiently resistant to a flow of water to

retain water within said housing against the force of gravity, while being permeable to a flow of water under a pressure differential up to between 4 inches of mercury.

36. A portable water purification system according to claim 13 wherein said biocidal resin comprises a sufficient quantity of biocidal resin to kill up to 1.5×10^6 cholera causing bacteria per milliliter in said flow of water.

37. A portable water purification system according to claim 14 wherein said biocidal resin comprises a sufficient quantity of biocidal resin to kill up to 2.0×10^4 giardiasis causing cysts per milliliter in said flow of water.

38. A water purification system according to claim 16 wherein said adsorbent enhancer comprises silver.

39. A water purification system according to claim 26 wherein at least on said water permeable member is sufficiently resistant to a flow of water to retain water within said housing against the force of gravity.

40. A portable water purification system according to claim 27 wherein said biocidal resin comprises a sufficient quantity of biocidal resin to kill up to 1.5×10^6 cholera causing bacteria per milliliter in said flow of water.

41. A portable water purification system according to claim 28 wherein said biocidal resin comprises a sufficient quantity of biocidal resin to kill up to 2.0×10^4 giardiasis causing cysts per milliliter in said flow of water.

42. A water purification system according to claim 30 wherein said adsorbent enhancer comprises silver.

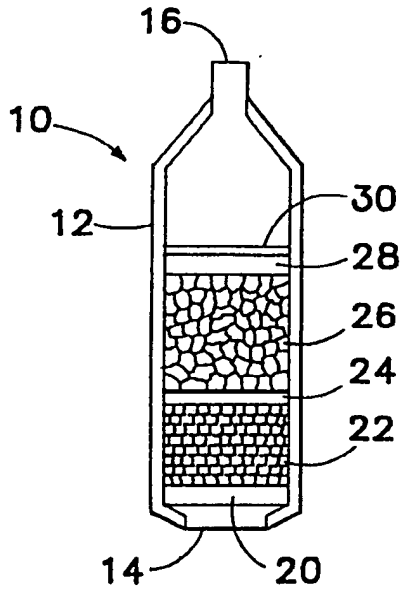


Fig. 1

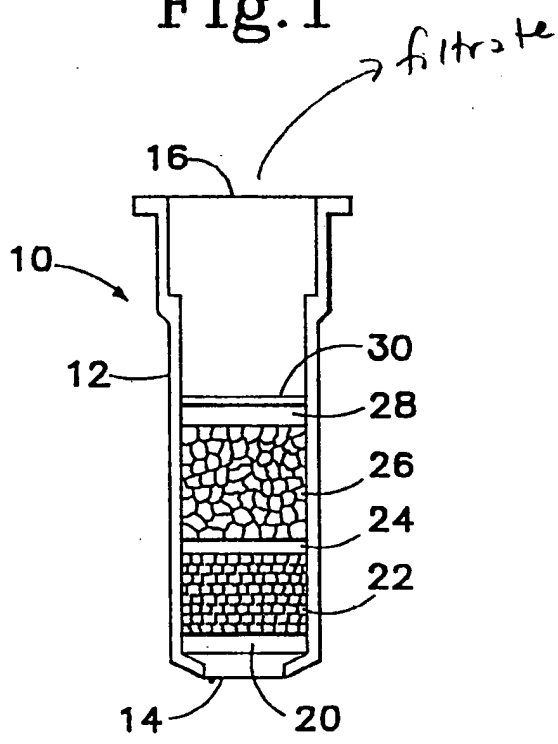


Fig. 2

prefill

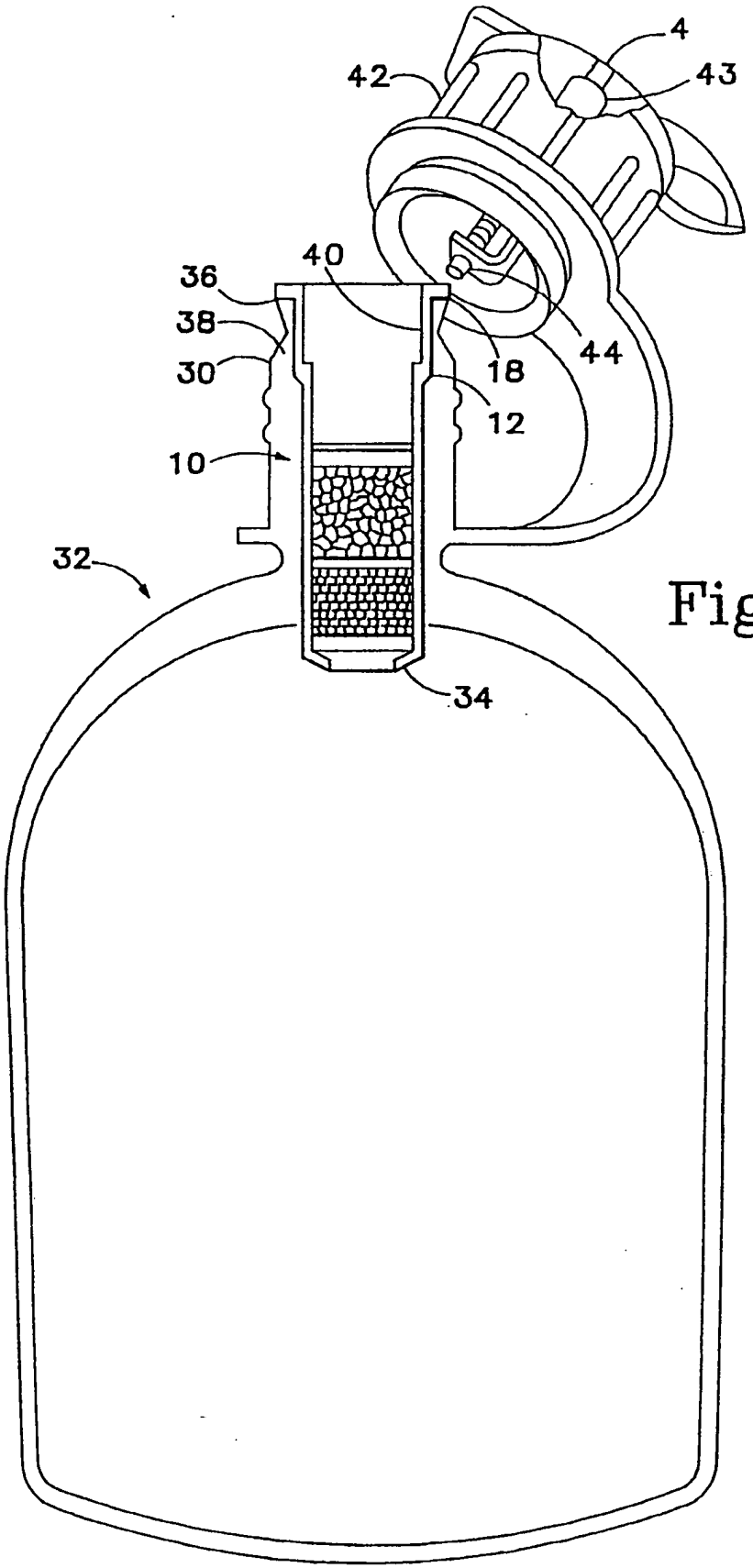


Fig. 3

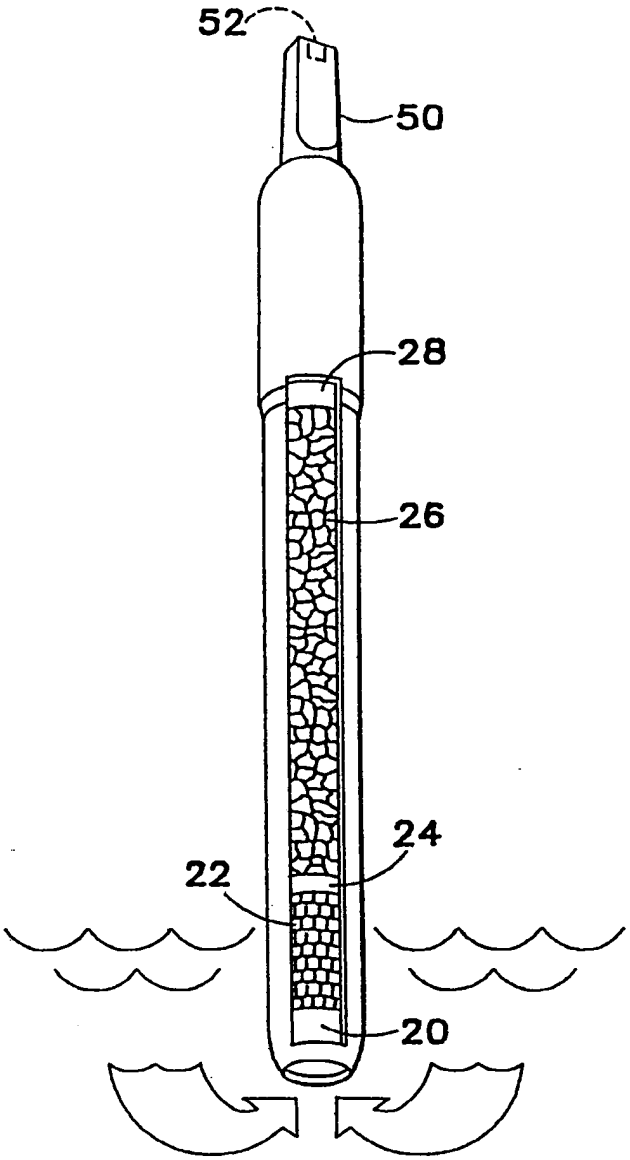


Fig. 4

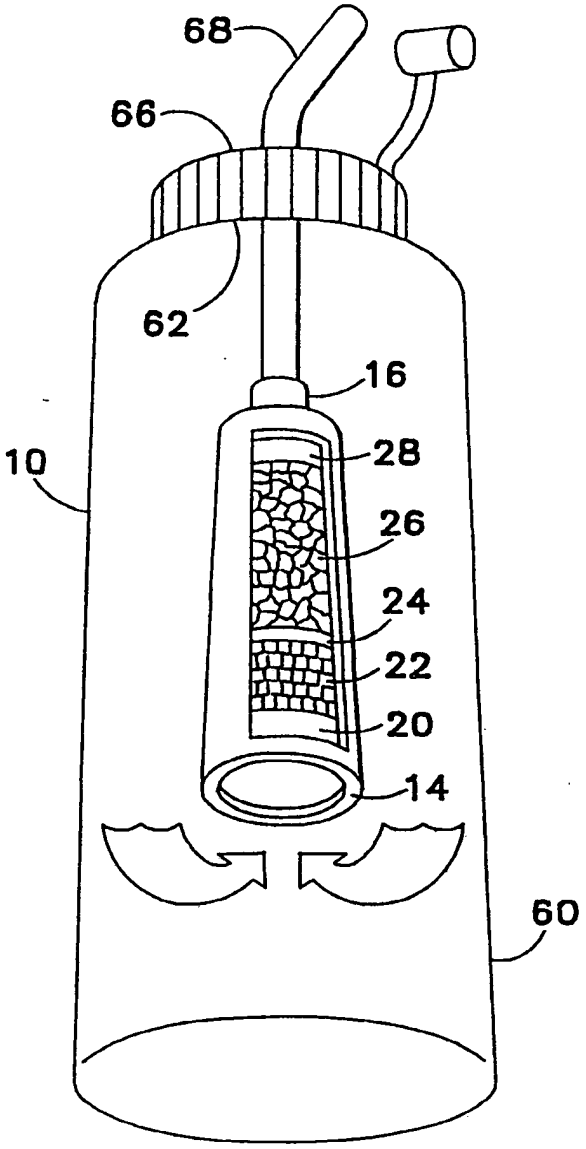


Fig. 5

suck and/or squeeze to effect filtration (7, 17+)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US93/02631

A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) :B01D 24/08
US CL :210/266,282,283,289,501,502.1
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 210/202,287,290,502; 424/179,150

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US, A, 4,995,976 (VERMES ET AL.) 26 February 1991, See entire document.	1-7,21,22, 32,33 8-20,23-31, 34-42
Y	US, A, 4,769,143 (DEUTSCH ET AL.) 06 September 1988, See col. 2, lines 33-39.	8,16,30,34, 38 & 42
Y	US, A, 4,714,550 (MALSON ET AL.) 22 December 1987, See entire document.	9-16,17-20, 35-38
Y	US, A, 5,045,195 (SPANGRUD ET AL.) 03 September 1991, See entire document.	4-8,12-20, 26-42
A,P	US,A, 5,126,044 (MAGNUSSON ET AL.) 30 June 1992, See entire document.	1-42

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be part of particular relevance

"E" earlier document published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
24 MAY 1993

Date of mailing of the international search report
07 JUN 1993

Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231

Facsimile No. NOT APPLICABLE

Authorized officer
CYNTHIA L. NESSLER

Telephone No. (703) 308-3843

Form PCT/ISA/210 (second sheet)(July 1992)★